

3.28 RANGE TRACK

The function of the range tracker is to continuously place the radar range gate at the true target slant range. Range track is typically implemented with an error sensing range gate (i.e., a split range gate), that senses the error between the perceived target range and the position of the range gate. The range servo attempts to correct the position of the range gate by minimizing the error.

Two major components are imbedded in the range track loop illustrated in Figure 3.28-1: the range discriminator and the servo element which repositions the range gate. The range discriminator determines the error between target range and range gate center and sends a corrective command to the servo. The servo responds by centering the gate on the perceived range to the target.

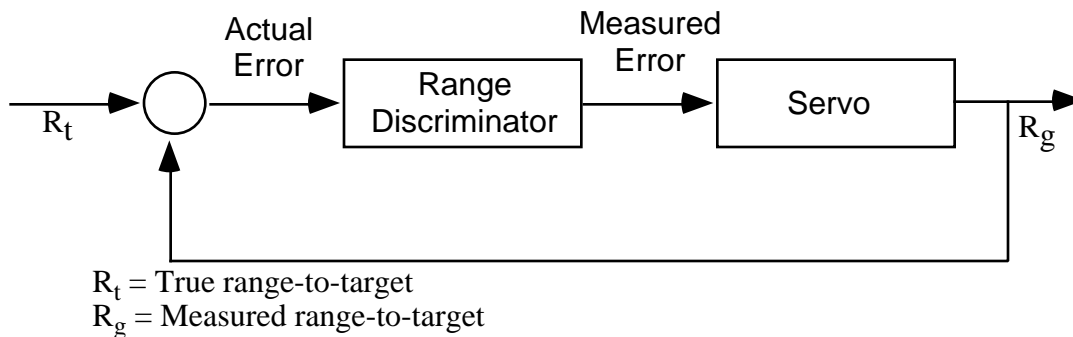


FIGURE 3.28-1. Range Track Loop.

In RADGUNS, the range gate opens momentarily once each pulse repetition interval (PRI) to let the target return into the receiver. Otherwise, it is closed. This prevents the radar tracking circuitry from being distracted by signals at ranges other than the target range. Because the gate may not be set to close at exactly the proper time, some or all of the target pulse may be blocked. Modeling of the range tracking servos is accomplished by subroutine RSERVO that calculates a response to the range error signal by averaging the receiver angle channel output for one scan, in volts.

Data Items Required

Data Item	Accuracy	Sample Rate	Comments
7.2.1 Radar range	± 5 m	10 Hz	AKA reported range.
7.2.2 Actual range	± 5 m	10 Hz	

3.28.1 Objectives and Procedures

Range track is sensitive to rates of change in the radial velocity of the target. Target size, speed, and distance from the threat also influence range track.

RADGUNS was executed with the following input conditions:

- | | | |
|----|-----------------------------|--|
| a. | Model mode: | SNGL/RADR/MTI OFF |
| b. | Target radar cross section: | 0 dBsm |
| c. | Target presented area: | 1.0 m ² , 10.0 m ² |
| d. | Target speed: | 50, 150, 300 m/s |
| e. | Target flight path: | LINEAR |
| f. | Guns: | Disabled |
| g. | Output: | Range tracking errors |

Targets with presented areas of one and ten square meters were flown within tracking range of the radar at speeds of 50, 150, and 300 m/s. Beginning at a range of 7000 m, the target flew toward the radar, then away, crossing over approximately halfway through the flight. Different offsets from the radar were used to vary the stress on the range tracker.

3.28.2 Results

Plots of range error versus time are depicted in Figures 3.28-2 through 3.28-7 for the two target sizes at offsets of zero and 1000 meters. These figures show the effects of target speed, size, and offset on range tracking. For the zero offset case, range errors are extremely small, regardless of speed, until the target passes directly overhead and a break lock occurs. The effect of target size on range tracking is more apparent when the target is offset from the threat.

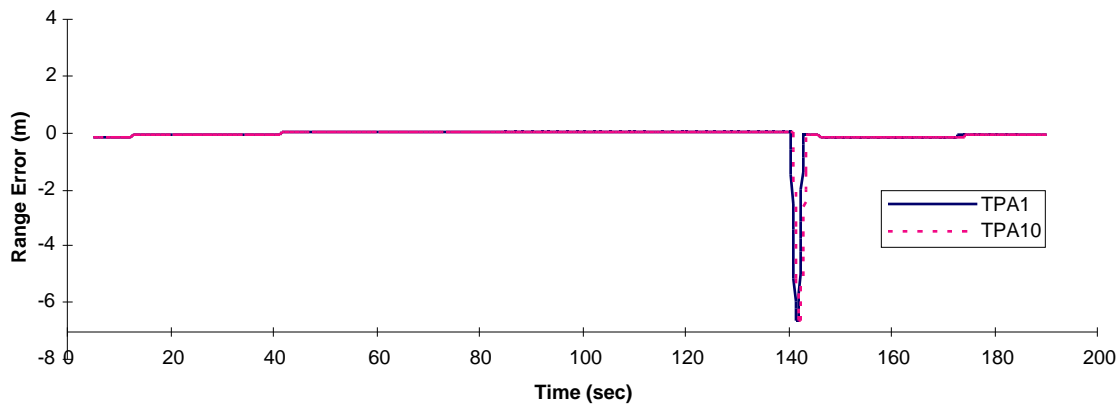


FIGURE 3.28-2. Range Track Errors for 50m/s Target at Zero Offset.

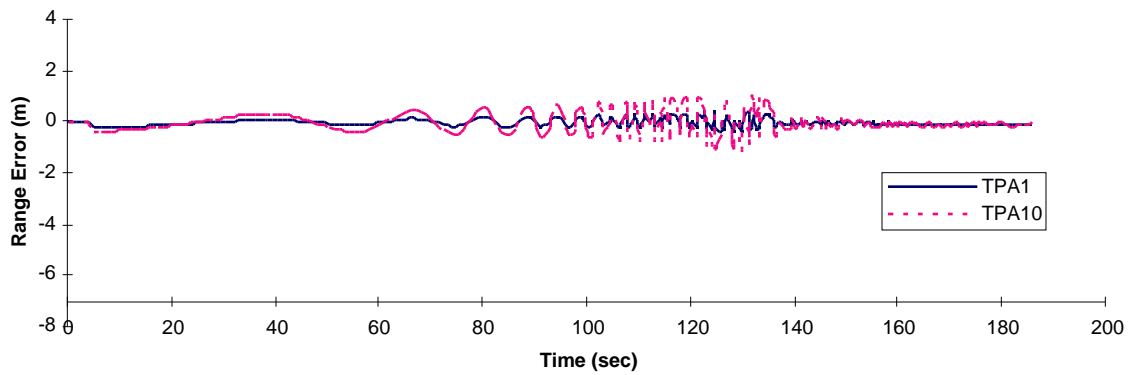


FIGURE 3.28-3. Range Track Errors for 50m/s Target at Zero Offset.

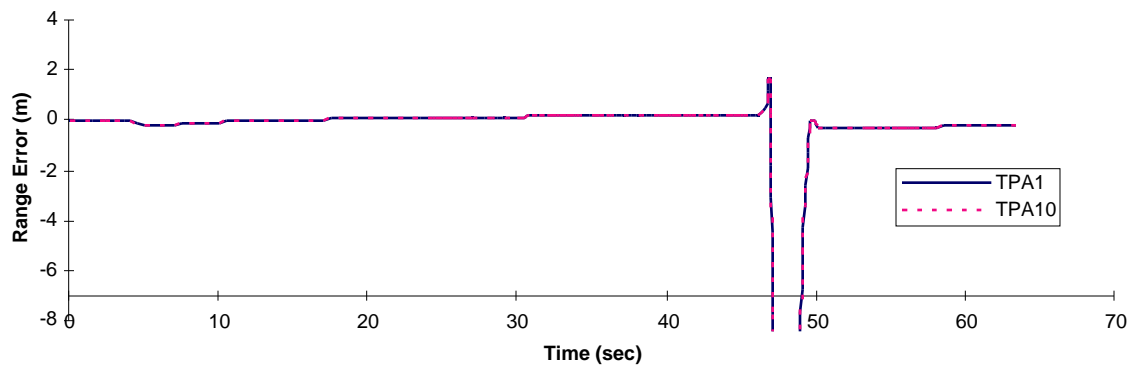


FIGURE 3.28-4. Range Track Errors for 150m/s Target at Zero Offset.

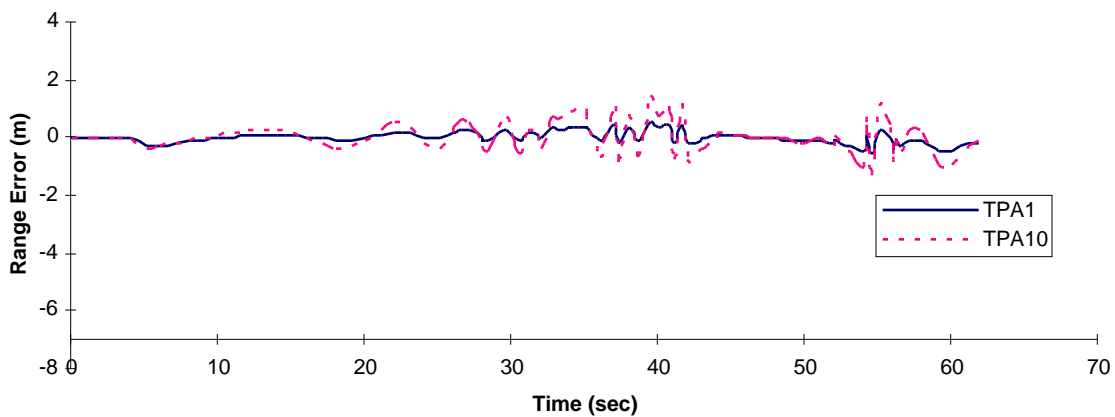


FIGURE 3.28-5. Range Track Errors for 150m/s Target at 1 km Offset.

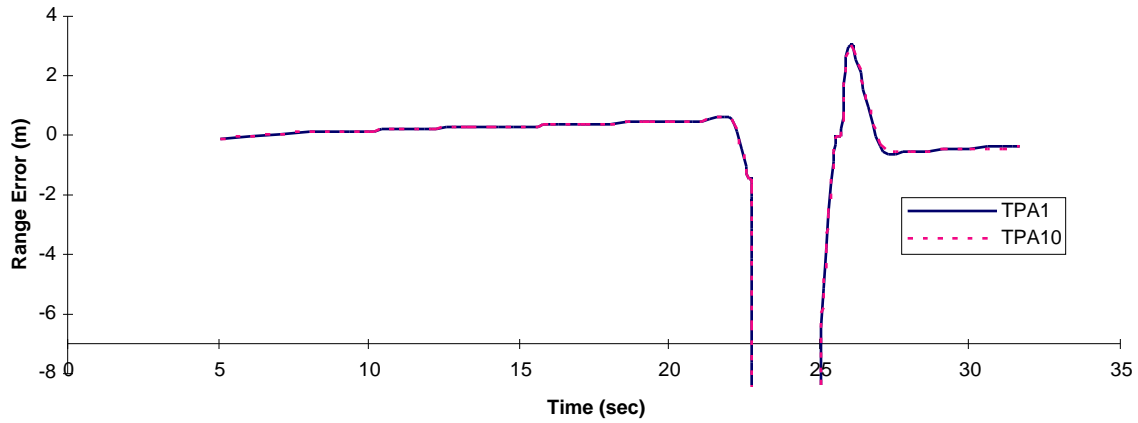


FIGURE 3.28-6. Range Track Errors for 300m/s Target at Zero Offset.

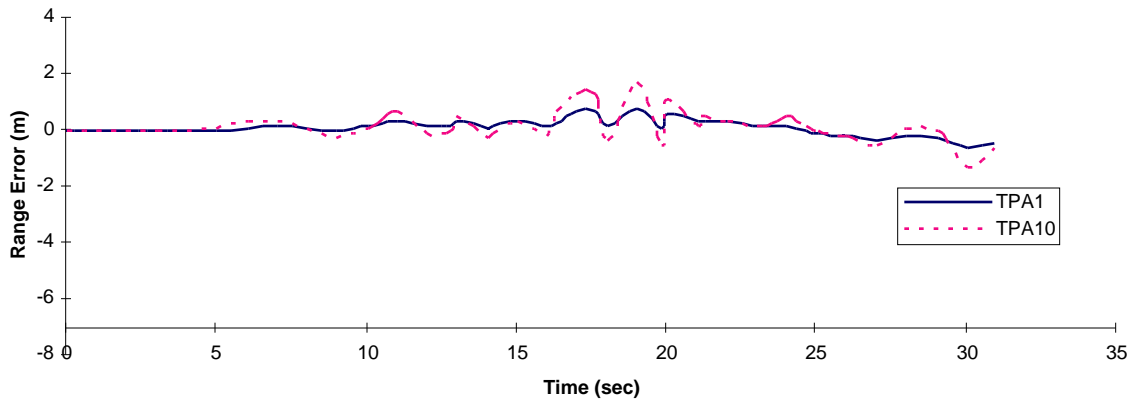


FIGURE 3.28-7. Range Track Errors for 300m/s Target at 1 km Offset.

Figure 3.28-8, the RMS range tracking error output of RADGUNS shows the combined effects of target speed and size. An increase in either target speed or size results in an increase in errors. Range tracking errors are more sensitive to target size than speed.

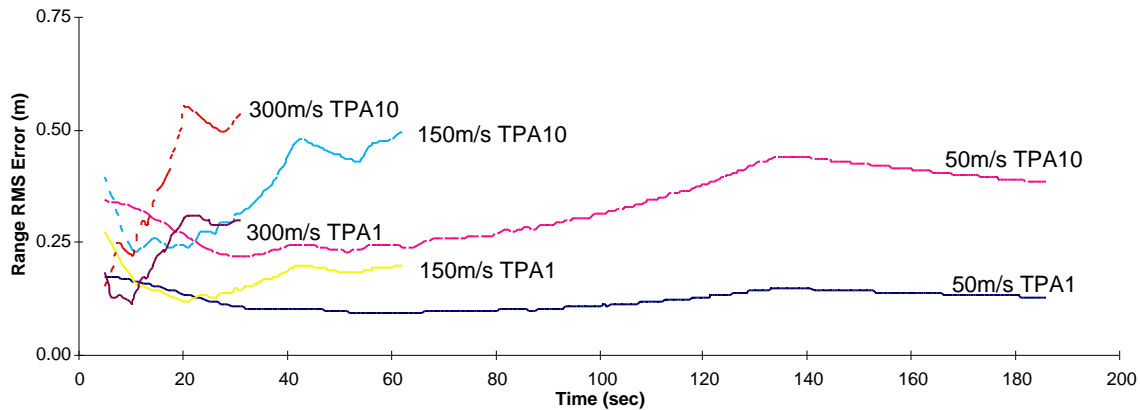
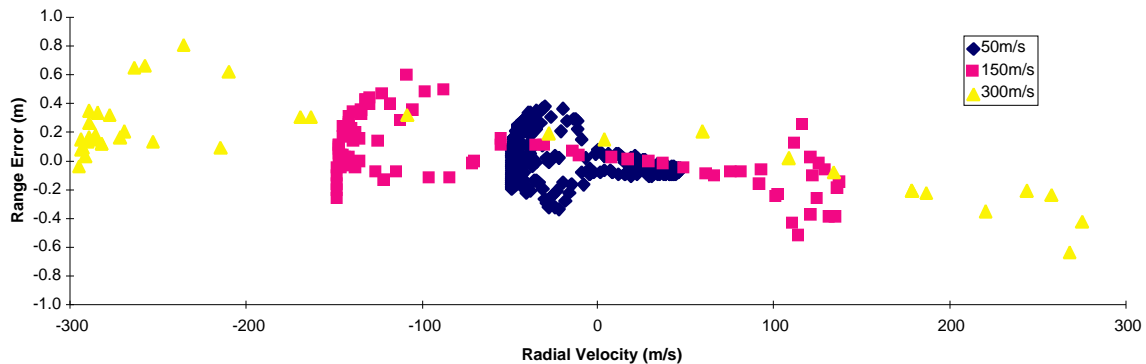


FIGURE 3.28-8. RMS Range Tracking Errors.

Figures 3.28-9 and 3.28-10 show the effect of radial velocity on range tracking errors for two target sizes at three speeds. As radial velocity increases, range errors increase. Incoming targets produce predominately positive errors while outgoing targets produce predominately negative errors. Figures 3.28-11 and 3.28-12 show the effect of target range on range errors. Range error is inversely proportional to target range.

FIGURE 3.28-9. Range Tracking Errors as a Function of Radial Velocity, 1 m² Target.

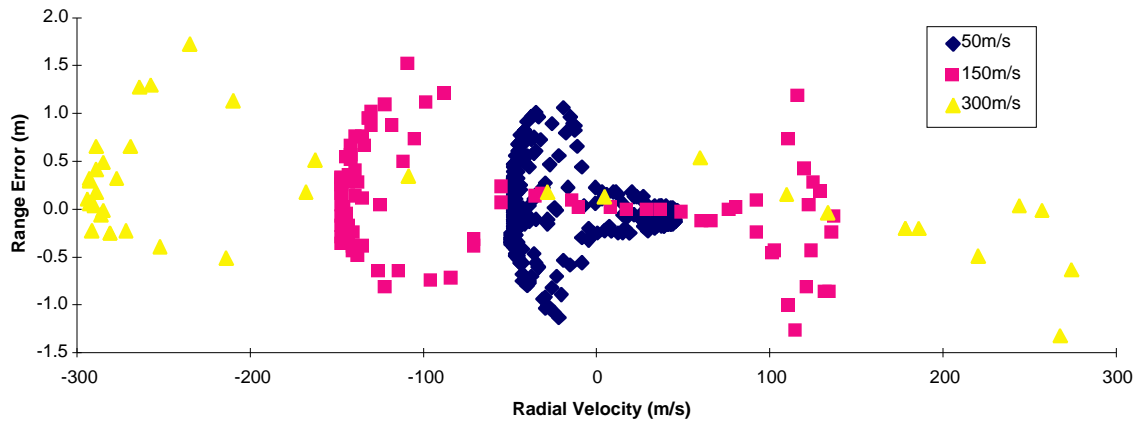


FIGURE 3.28-10. Range Tracking Errors as a Function of Radial Velocity, 10 m² Target.

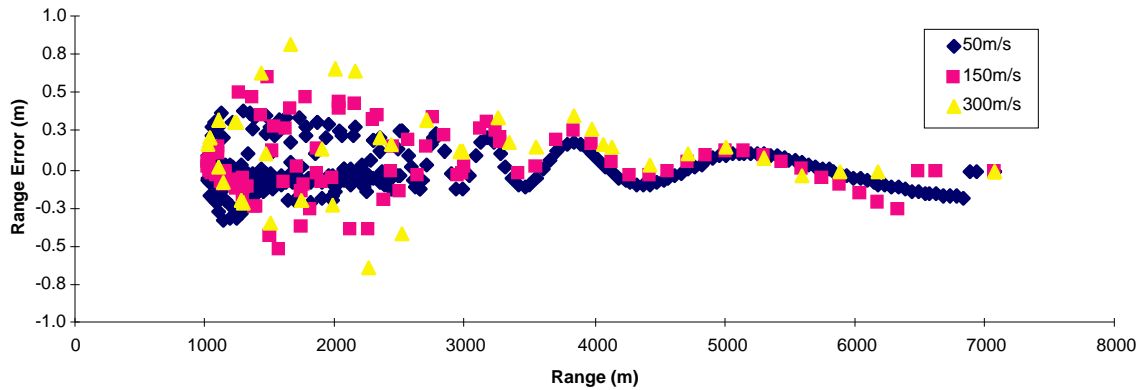


FIGURE 3.28-11. Range Tracking Errors as a Function of Range, 1 m² Target, Zero Offset.

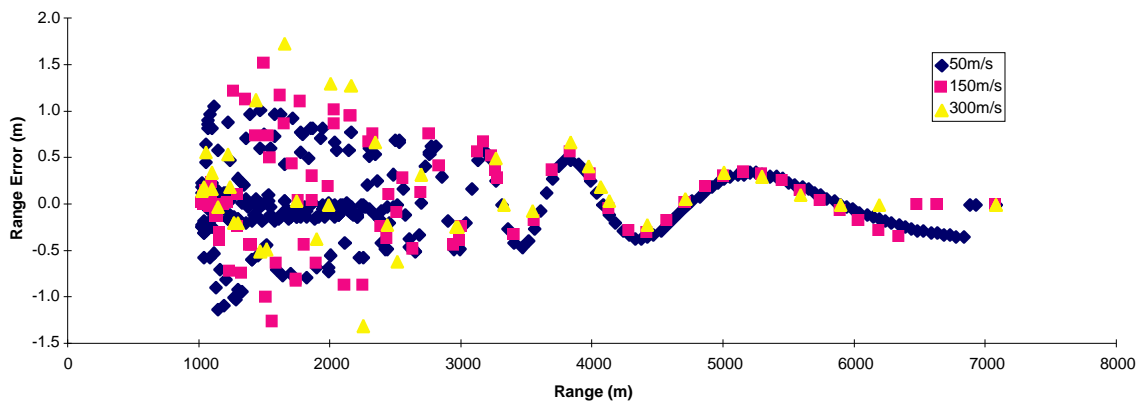


FIGURE 3.28-12. Range Tracking Errors as a Function of Range, 10 m² Target, Zero Offset.

Figures 3.28-13 through 3.28-15 display the distribution of range tracking errors at each target speed and size. As target speed increases, the mean increases slightly. Target size has the greatest impact on range error.

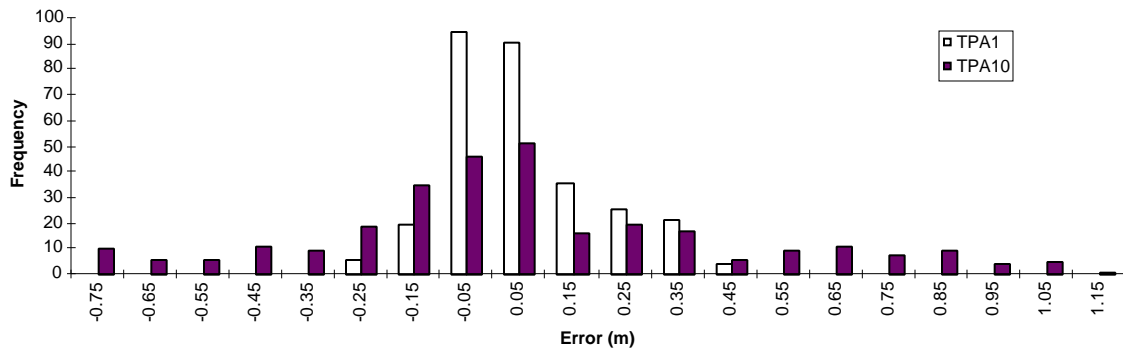


FIGURE 3.28-13. Distribution of Range Tracking Errors for 50 m/s Target.

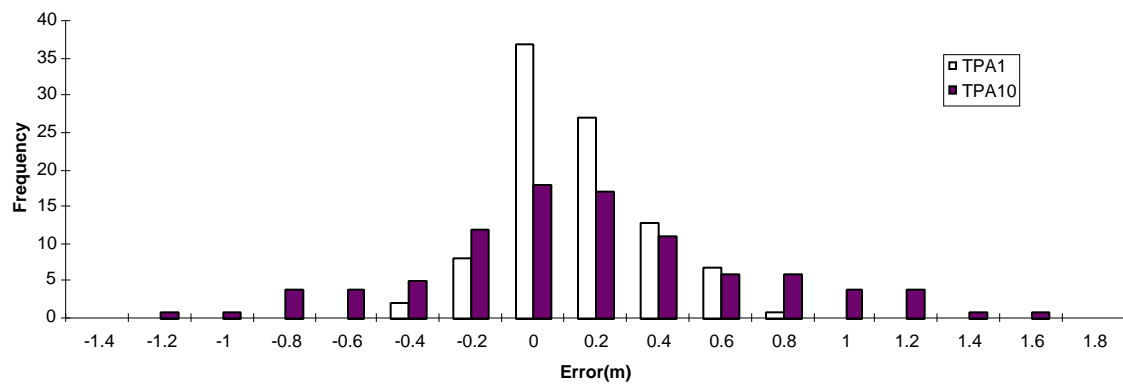


FIGURE 3.28-14. Distribution of Range Track Errors for 150m/s Target.

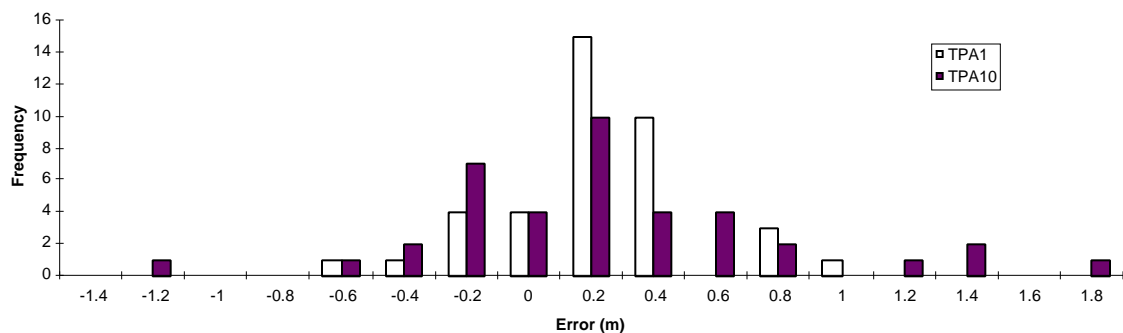


FIGURE 3.28-15. Distribution of Range Track Errors for 300m/s Target.

3.28.3 Conclusions

The range tracking function of RADGUNS is sensitive to both target speed and size. The range tracking errors are outlined for the two target sizes at different speeds in Table 3.28-1.

TABLE 3.28-1. Range Tracking Errors as a Function of Target Speed and Size.

Velocity (m/s)	One Square Meter Target		Ten Square Meter Target	
	Mean (m)	Error Bounds (m)	Mean (m)	Error Bounds (m)
50	0.01	-0.33 to 0.39	0.01	-1.13 to 1.06
150	0.05	-0.51 to 0.60	0.08	-1.27 to 1.52
300	0.11	-0.63 to 0.82	0.15	-1.30 to 1.74

An increase in target size of an order of magnitude approximately doubles the range error at all speeds (most easily seen for the offset case). An increase in target speed produces a slight increase in both the magnitude and range of errors. The frequency of oscillation of range errors is greatest for slow moving targets. Range errors for incoming targets are predominately positive while errors for outgoing targets are mostly negative (the range gate lags or leads the target depending on the direction of the radial velocity vector). While range errors are highly sensitive to target speed, it is important to note that the errors are quite small over a wide operating range.